

# PATENT SPECIFICATION

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## (54) AN ASSEMBLY OF TWO METAL PARTS, AND A METHOD OF JOINING THEM

(71) We, KLÖCKNER-HUMBOLDT-DEUTZ AKTIENGESELLSCHAFT, a German Body Corporate, of Köln-Deutz, German Federal Republic, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

The invention relates to an assembly of the cylinder head of an internal combustion engine and a cylinder tube, and to a method of fixing the parts together.

Many different ways of fixing two metal parts together are known in the art. The creation of such joints presents considerable difficulties when the two parts are made of different materials, as is the case when a cylinder tube is to be joined to a cylinder head in an internal combustion engine, the cylinder head being an aluminium alloy casting which expands to a much greater extent, because of its higher coefficient of thermal expansion and its higher temperature of operation, than the cylinder tube, which is of gray cast iron. Principally because of the unequal expansions between these different materials conventional methods of making joints do not give satisfactory results.

It is an aim of the present invention to provide a method of, and a means for forming such joints which solves the above described problems, besides being simple and cheap to produce.

According to one aspect of the invention, a method of fixing the cylinder head of an internal combustion engine to a cylinder tube comprises the steps of forming on the cylinder head a spigot which will fit into the cylinder tube, forming an external circumferential groove on the spigot and an internal circumferential groove in the cylinder tube, the grooves being so shaped and positioned that when the spigot is inserted into the cylinder tube the two

grooves form a continuous annular cavity, and filling the cavity with a metal-to-metal adhesive or with molten metal to join the parts and form a key between them. The metal-to-metal adhesive, or the metal, which is filled into the cavity forms a kind of interlocking intermediate element which ensures the formation of a strong joint between the two parts. Moreover, the intermediate element formed by the metal-to-metal adhesive or the metal filling is compressible and can therefore compensate for differences in expansion between the two parts.

From another aspect, the invention provides an assembly of the cylinder head of an internal combustion engine with a cylinder tube, in which the cylinder head comprises a spigot which fits into the cylinder tube, the spigot is formed with an external circumferential groove and the cylinder tube is formed with an internal circumferential groove, the grooves being so shaped and positioned that when the spigot is inserted into the cylinder tube the grooves together form a continuous cavity extending around the spigot and cylinder tube, the cavity being filled with a metal-to-metal adhesive or with a metal different from the metal of which the cylinder head or the cylinder tube are made.

When a liquid metal is filled into the space, for instance by a kind of pressure casting technique, a high strength joint is formed which possesses inherent elasticity, depending upon the nature of the metal employed.

In such a joint it is desirable that the annular cavity should communicate with the outside through at least one filling opening and one venting opening located preferably on diametrically opposite sides, the parts being so positioned during filling that the filling opening is vertically below the venting opening and that at least the filling opening

is capable of being sealed after filling.

It is then easily possible to fill or force a metal-to-metal adhesive, or a liquid metal into the filling opening since the air can escape from the venting opening at the top. Finally, at least the filling opening can be sealed to prevent the adhesive or the liquid metal from running out before it has had time to set.

Where a metal-to-metal adhesive is used, the adhesive may contain a metallic filler material. This improves the strength of the jointing material so that the resultant joint can absorb forces while at the same time permitting elastic deformation between the several parts.

For the further elucidation of the nature of the invention, reference will now be made to an embodiment shown in simplified form in the accompanying drawings, in which:—

Figure 1 is a schematic longitudinal section of a cylinder head and a cylinder; and

Figure 2 is a cross-section of the cylinder head and cylinder taken on the line II - II in Figure 1.

Referring to Figures 1 and 2, an internal combustion engine, not shown in detail, comprises a cylinder head 1. This cylinder head 1 has a spigot having a cylindrical peripheral surface 1a which fits into a cylinder tube, likewise only shown in a general manner. The cylindrical peripheral surface 1a and the contacting surface of the cylinder tube 2 each contain a peripheral groove, the two grooves together defining a continuous annular cavity 3 (Figure 2). Through a radial filling opening 4 and venting opening 5 on diametrically opposite sides, the annular cavity 3 communicates with the outside. In order to fill the annular cavity 3 with a metal-to-metal adhesive, which may contain a metallic filler material, the assembled cylinder head and cylinder tube in Figure 1 are tilted roughly 90° into a position in which the filling opening 4 is at the bottom and the venting opening 5 is roughly vertically above, at the top. The metal-to-metal adhesive is then forced into the filling opening 4 whilst air and dirt can escape from the opening at the top. When the annular cavity has been filled the filling opening 4 is plugged until the metal-to-metal adhesive inside the cavity has set. A joint of satisfactory strength which permits some elastic movement between the two parts will thus be formed. The degree of elastic yield can be determined by choosing the capacity of the annular cavity 3 in relation to the total area of contact between the cylinder head and the cylinder tube, or by providing appropriate clearance between the two parts.

The adhesive may be a commercial type of metal-to-metal adhesive which, according to the nature of its application, should be resistant to heat and high temperature.

In order to achieve an even stronger joint the annular cavity may also be filled with liquid metal by pressure casting. Where a metal-to-metal adhesive is used it may be of a kind which, when set, merely forms a key between the parts, or it may be of a kind which bonds with the metal of the parts. Where a molten metal is used, it may be a metal which will merely form a key between the parts or it may be a metal which will bond or locally alloy with the metals of the two parts at the interfaces.

#### WHAT WE CLAIM IS:

1. A method of fixing the cylinder head of an internal combustion engine to a cylinder tube comprising the steps of forming on the cylinder head a spigot which will fit into the cylinder tube, forming an external circumferential groove on the spigot and an internal circumferential groove in the cylinder tube, the grooves being so shaped and positioned that when the spigot is inserted into the cylinder tube the two grooves form a continuous annular cavity, and filling the cavity with a metal-to-metal adhesive or with molten metal to join the parts and form a key between them.

2. A method according to claim 1, comprising the step of providing at least one filling opening and one venting opening leading from the exterior of one of the parts into the cavity.

3. A method according to claim 2, comprising the step of placing the openings in diametrically opposite locations, so positioning the parts during filling that the filling opening is vertically beneath the venting opening, and sealing at least the filling opening after filling.

4. A method according to any preceding claim, in which a metal-to-metal adhesive is used, comprising the step of incorporating a metallic filler material in the adhesive.

5. An assembly of the cylinder head of an internal combustion engine with a cylinder tube, in which the cylinder head comprises a spigot which fits into the cylinder tube, the spigot is formed with an external circumferential groove and the cylinder tube is formed with an internal circumferential groove, the grooves being so shaped and positioned that when the spigot is inserted into the cylinder tube the grooves together form a continuous cavity extending around the spigot and cylinder tube, the cavity being filled with a metal-to-metal adhesive or with a metal different from the metal of which the cylinder head or the cylinder tube are made.

6. An assembly according to claim 5, in which the cavity is formed with two diametrically opposite openings extending to the outside of the cylinder tube, which enable the adhesive or the different metal to be introduced into the cavity.

7. An assembly according to claim 5 or claim 6, in which the parts are joined by a metal-to-metal adhesive, comprising a metallic filler material in the adhesive.
- 5 8. A method of fixing the cylinder head of an internal combustion engine to a cylinder tube, substantially as herein described, with reference to and as illustrated in the accompanying drawings. 15
- 10 9. An assembly of the cylinder head of an internal combustion engine with a cylinder tube, constructed and arranged substantially as herein described, with reference to and as illustrated in the accompanying drawings.
- BROMHEAD & CO.,  
Chartered Patent Agents,  
Clifford's Inn,  
Fetter Lane,  
London EC4A 1NP.

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FIG. 1

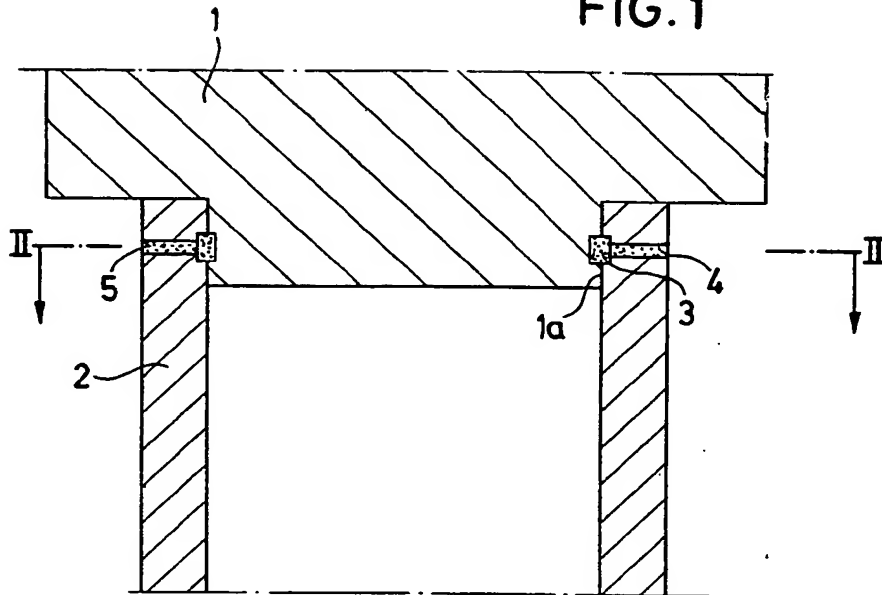


FIG. 2

